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Epidemiological and Entomological investigation during outbreak of malaria in village Bonta, PHC Kivani, UT of Dadra & Nagar Haveli, India

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Abstract
A focal outbreak of malaria at Bonta sub-centre of PHC Kilvani, the UT of Dadra & Nagar Haveli was reported during the month of August, 2014. Seven villages of the above block were affected. During the episode, around 757 fever cases were reported with Slide Positivity Rate (SPR) of 11.6%. The malaria epidemiological data for last three years from the subcentre area indicates that the area is endemic for malaria (API was >5). Entomological survey revealed the presence of three known vectors of malaria viz. *Anopheles culicifacies, A. stephensi* and *A. subpictus*. Per Man Hour Density (PMHD) of these three vector species were 11.2, 1.2 and 7.8 respectively.

Keywords: Malaria, Outbreak, Plasmodium, Epidemiology, Entomology

1. Introduction
Various vector borne diseases mainly the malaria account for 17 percent of the global burden of infectious diseases [1]. Malaria outbreaks are the complex public health challenges attributed to both natural and man-made causes. In India, scenario is mostly unstable and outbreaks occur frequently in various parts of the country. The reasons for malaria epidemics and outbreaks are identified as inadequacy of surveillance, shortage of human resources, residual spray in rural areas, anti-larval measures in urban areas, population migration (in or out of an endemic area), increase in breeding sites and vector population, presence of new efficient vectors, drug resistance in parasite or insecticide resistance in vectors and break down in the control measures [2]. Most effective strategy of the National Vector Borne Diseases Control Programme (NVBDCP) is on early diagnosis and prompt, complete and effective treatment. Malaria diagnosis is carried out by microscopic examination of blood films collected by active and passive agencies. Health agencies and volunteers treating fever cases in inaccessible areas are being provided with Rapid Diagnostic Test (RDT) kits (Bivalent RDT) for diagnosis of Malaria cases so as to provide full radical treatment to the confirmed cases [3]. In the recent past, outbreaks had been reported from different states of India, such as, Orissa [4], Haryana [5], Chhattisgarh [6, 7], Rajasthan [8], Assam [9, 10, 11, 12], Bihar [13] and North India [14]. Since human behavior and change in environment plays important role in the transmission dynamics of mosquito borne disease, this study was undertaken to determine the epidemiological and entomological study with association of malaria outbreak in the study area.

2. Material and methods
2.1 Study area
The Union Territory of Dadra Nagar Haveli is in western part of India. Silvassa, the capital city of Dadra Nagar Haveli is situated at latitude, 20° 54’ 41’’ N to 20 ° 21’ 36’’ N and Longitude – 72° 54’ 41’’ N to 73° 13’ 13’’ N in the Western Ghat. The 487 sq km area is forest hill area, occupied by mainly tribes (population 3.42 lakh) in 72 villages and one town. The Bonta is sub-centre in eastern part of the UT of Dadra & Nagar Haveli border area of Gujarat.

2.2 Study Population
About 4000 (approx) people residing in tribal foothill village of subcenter Bonta (Village, Dungripada, Khaminimal, Mahabavi, Borsapada, Kuvapda, Dhamanpada, Khoripada, Khambhipada, Theripada etc.) were reported to be affected by the outbreak**.**

2.3 Clinical & Parasitological monitoring
A camp was organized by the Rapid Response Team, Dadra & Nagar Haveli and local health providers like ASHA and MPHW, for early identification and treatment of the fever cases in the villages. The finger prick blood samples were collected from all the fever cases for detection of *Plasmodium* parasite by rapid diagnostic test (RDT) and microscopic observation. Those found positive by RDT were treated with antimalarial drug as per the National Drug Policy immediately in the camp. The blood slide with thick and thin smears were brought to the PHC Laboratory and stained with Jaswant Singh and Bhattacharji (JSB) stain for microscopical examination. The secondary data was collected from concerned subcenter and PHC.

2.4 Entomological survey
Entomological survey was conducted in the affected villages following standard method [15]. Indoor resting adult mosquitoes were collected in the morning from 6 am to 9 am from randomly selected 30% of households and cattle shade using sucking tube. Each house was surveyed for 15 minutes. The mosquitoes were identified by appropriate keys [16] and Per Man Hour Density (PMHD) of each species of mosquitoes were calculated (PMHD= Total no. of mosquitoes collected /No. of person x Time spent in hours).

2.5 Larval survey
All kinds of breeding habitats; artificial (e.g. overhead tanks, plastic containers, iron/metal drums, junk materials, discarded tyres, coconut shells and curing tanks, etc.) and natural (rivers, streams, ponds, wells rice field, tree holes etc) were searched within one kilometers radius of the affected villages with the help of flash-light (torch). Anopheline mosquito larvae were searched using dippers of 10 centimeter diameter and 300 ml capacity (five dips at each site). Larval samples were brought to the laboratory for rearing till the adult emergence and then the mosquitoes were identified up to species level. Larval densities were expressed per site as the number of larvae per five dips.

3. Result
The secondary data of malarial outbreak (reported in 2010, 2011 and 2012) indicated that the UT of Dadra & Nagar Haveli is highly endemic for malaria (annual parasitic index more than 10). However the API reduced in 2013 and reach 4.54 in year 2013 (Table 1). The parasitological data Kilvani indicates that the endemicity of malaria in PHC Kilvani is less than PHC of other areas such as like Mandoni, Dudhani and Khanvel. The API of PHC Kilvani was recorded 4.1 in copulas in 2011 and 2012, 2.1 in 2013 along with 5.4 to 8.33 ABER (Annual Blood Examination Rate). API of sub center Bonta was counted 7.94 in year 2012, increased in 2013 and reached 11.47. The data of previous year indicated that sub center Bonta is endemic for malaria.

Table 1: Indicator of malaria reported from UT of the Dadra & Nagar Haveli.

Year	ABER	API	SPR	SFR
2010	19.31	16.91	8.75	3.44
2011	16.59	14.54	8.76	3.54
2012	27.31	13.35	4.89	2.13
2013	16.06	4.54	2.82	0.82

Table 2: Showing the epidemiological situation of Malaria in the PHC KilvaniKilvani

Year	ABER	API	SPR	SFR
2013	5.54	2.1	3.8	0.38
2012	8.33	4.1	4.9	0.91
2011	5.4	4.1	7.7	1.21

3.1 Epidemiological Survey
In July - August 2014, incidence of malaria associated with fever was reported from subcenter Bonta of PHC Kilvani, the UT of Dadra & Nagar Haveli. 88 confirmed cases of *P. vivax* occurred in subcenter Bonta from 14 July to 30 August. However, in 2012 and 2013, only 29 and 43 cases of malaria were reported from aforesaid area during same period. The episode of malaria was started from dated 14 July and continued up to 12/08/2014. Up to 18/08/2014, 24 cases of PV were reported from PHC. Occurrence of 24 cases of malaria within a short period represents an unusual event in subcenter Bonta. The department recognized the unusual increase of malaria cases in subcenter Bonta on date 18/08/2014 and order to rapid response team for Investigation. The investigation revealed affected villages of the PHC Kilvani, a camp was organized by the Rapid Response Team, Dadra & Nagar Haveli and local health providers like ASHA and MPHW (female and Male), for early identification and treatment of the fever cases in the effective villages. During house to house survey a total of 757 blood smears were collected from those people with symptoms of fever. A total of 64 cases of *Plasmodium vivax* (Pv) were reported from affected area (Fig. 1). The slide positivity rate (SPR) encountered 11.6 (ranged 2.5-14.5) in effected area. The result of fever surveillance show that the most effected villages are Dugripada, following to Khamanimal, Mahabavi, Borsapada, Khoripada, Dhamanpada and Kuvapada, along with SPR 14.5, 13.9,13.2,12.6, 2.78, 2.7 and 2.5 respectively. All age groups were affected in this outbreak. The age specific attack rate of *P vivax* was found to be high with 35.1 % among the group of people aged 16-54 years. In sex wise distribution, the males were found to be more affected 48 (55.2%) than females 40 (45.5%).

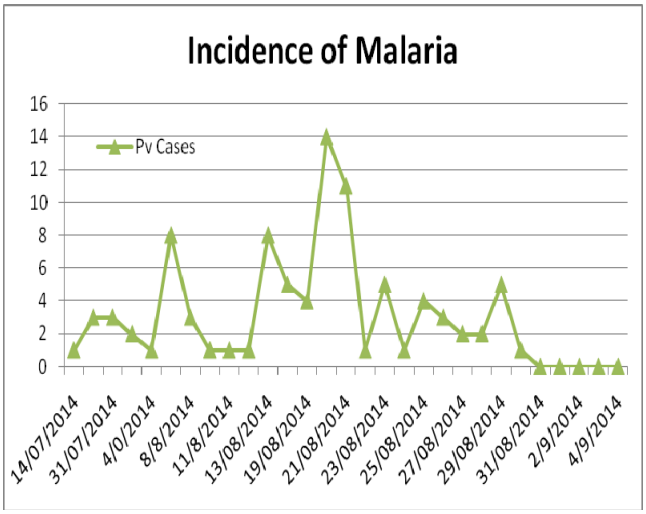

Fig 1: Showing date wise incidence of malaria during outbreak in Subcenter Bonta

3.2 Entomological observation

Three species of *Anopheles* mosquitoes (*An. culicifacies*, *An. stephensi* and *An. Subpictus*) were collected through sucking tube methods from human dwellings; cattle shed and mixed dwelling. The PMHD of the primary vector, *An. culicifacies* was 11.2 which was higher than the critical density. The highest density of *Anopheles* reported from cattle shed followed by mixed dwelling and human dwelling. During investigation, it was also observed that the preferred resting site of vector in human dwelling was hanging cloth. The proportion of unfed (UF), full fed (FF), semi gravid (SG) and gravid (G) condition of major vector species (*An. culicifacies*) are recorded 57.1, 10.7, 21.4 and 10.7 respectively (Table 3).

Table 3: Showing Vector Species of Malaria reported from subcenter Bonta

Species Name	Abdominal condition				Total	PMHD
	UF (%)	FF (%)	HG (%)	G (%)		
An. Culicifacies	57.1	10.7	21.4	10.7	112	11.2
An. Stephensi	50.0	16.7	8.3	25.0	12	1.2
An. Subpictus	66.7	15.4	14.1	3.8	78	7.8

3.3 Larval survey

During larva investigation, it was seen that the preferred breeding site of *A. culicifacies* is bank of Foothill River (Ratkhadi Stream) in Bonta Subcenter. However it is also observed that the mixed breeding of Anopheline and *Aedes* is up to alarming level at the village of Bonta. Overall 22.3% container, 46.9 % House were found positive and Breteau Index was reported 80 in the Village of Bonta. During communication with local person, it is come to notice that local peoples have storage tendency of water due to irregular supply of water. (Table 4).

Table 4: Showing Larval survey in the study areas during the malaria outbreak

Type of breeding place	Nos. of larvae collected	Larval density/dip	Species of larvae
Slow moving Stream	180	36	An. Cul, An. sub.
Well	52	10.4	An. cul, An. sub., An. ste
Tyres	6	1.2	Ae. age, An. ste
Tin Containers	0	0	Ae.age
Clay Pots	4	0.8	Ae. age, An. ste,
Plastic Containers	12	2.4	Ae. age, An. ste,
Others	6	1.2	Ae. age, Ae. albo, An ste.

4. Discussion

Malaria is one of the major public health problem in the UT of Dadra & Nagar Haveli from long time. High vector density, the poor socio-economic condition, lack of awareness in community about malaria and presence of parasite load in the community make the population more vulnerable for contacting malaria, as locals are not in the habit of using mosquito nets or any other personal protection measures. Repeated infections due to frequent man-mosquito contact and non-clearance of parasites from the blood because of under-dosage of antimalaria drugs may develop immunity and asymptomatic carriers in the community [12]. The study from India, district Korea of Chhattisgarh, during 2009 reported malaria outbreak with SPR 22.2% and showed the average PMHD of *An. Culicifacies* is 5.5 [7]. The desert of Rajasthan has also experienced an outbreak during 1994 in small foci with stable malaria and the PMHD of *An. culicifacies*, *An. stephensi* were 3.4 and 3.7 respectively and. High value of SPR 60.1%, SFR 56.9% were observed, which might be due to appearance of stable malaria [8]. In our observation the outbreak reported with high density of *An. Culicifacies* (11.2) along with low SPR 11.6% in contrast of previous studies. The cause of outbreak may be rise in the larval population in the month of May and June might be due to stagnation of water in bank of Foothill river, accumulation of water for long time may favoured the development of microorganism (acts as a larval food) in the river, suitable environment for vector to survive long and parasite to grow inside the vector. A unique behaviour was noted that people released their cattle into forest grassland for grazing during pre-monsoon season (April to June). The primary vector *An. Culicifacies* is zoophilic in nature, in the absence of primary host (cattle) the vector depend on the secondary host (human) for feeding, this behaviour may be increase human and vector contact resulting increase in malaria transmission. Limited information is available on age and gender specific prevalence of malaria in different paradigms in the country. The burden is generally higher in males than females in all age groups [11]. Previous studies showed that children in the states like Assam, Arunachal Pradesh and Rajasthan had higher incidence of malaria in child than adults, whereas in the indo-gangetic plains the situation was reverse [11, 12, 14, 8]. During present investigation, person belong to age group 16-45 years were found to be highly susceptible and male dominancy on female, it could not confirmed previous studies as like Tripura [17], Assam and northeastern India [18], Central India [19] and Gujarat [20]. Malaria transmission in forest areas is a complex process involving interplay between topographical, entomological, parasitological and human factors. The experience from this study the following recommendations were made to avert malaria outbreak in future. i) Long-term and systematic monitoring of environmental risk factors, vector prevalence and disease surveillance at sub-centre level, ii) intensified Early Detection and Prompt Treatment (EDPT) of malaria cases, iii) early prediction of outbreak using the surveillance data, iv) implementation of situation specific malaria control strategies and v) promotion of the use of personal protection measures with long-lasting insecticide- treated bed nets. The above recommendations will help the local and public health authorities to face any challenges of malaria outbreak occurring in the non endemic area.

5. Conclusion

The outbreak of malaria is caused due to a number of factors as like climatic and non-climatic factors. Temperature, rainfall and relative humidity are the climatic variables. Parasites, vectors, human host factors, population movement or migration, deforestation, urbanization and interruption of control and preventive measures are the non-climatic factors. The non climatic factor as like vectors, human host factors may cause outbreak during non transmission period. The Studies on malarial outbreak in the UT of Dadra & Nagar Haveli may provide new insights on the cause of outbreak.

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